

WHAT IS CLAIMED IS

1           1. A magnetic recording medium  
2 comprising:

3           a first magnetic layer having a coercivity  $H_{c1}$ ;  
4           a second magnetic layer having a coercivity  
5  $H_{c2}$ ; and

6           a non-magnetic coupling layer provided between  
7 the first and second magnetic layers so that the  
8 first and second magnetic layers are exchange-  
9 coupled and magnetizations of the first and second  
10 magnetic layers are antiparallel;

11          said first magnetic layer having an exchange  
12 coupling field  $H_{ex1}$  that is larger than both said  
13 coercivity  $H_{c1}$  and said coercivity  $H_{c2}$ .

1           2. The magnetic recording medium as  
2 claimed in claim 1, wherein a switching field  $H_{sw*}$   
3 which switches the magnetization of said first  
4 magnetic layer to become parallel to the  
5 magnetization of said second magnetic layer is set  
6 to the sum of said exchange coupling field  $H_{ex1}$  and  
7 said coercivity  $H_{c1}$ .

1           3. The magnetic recording medium as  
2 claimed in claim 1, wherein a magnetization and  
3 thickness product  $t_1 M_{s1}$  of said first magnetic layer  
4 is smaller than a magnetization and thickness  
5 product  $t_2 M_{s2}$  of said second magnetic layer, where  
6  $t_1$  denotes a thickness of said first magnetic layer,  
7  $M_{s1}$  denotes a magnetization of said first magnetic  
8 layer,  $t_2$  denotes a thickness of said second  
9 magnetic layer, and  $M_{s2}$  denotes a magnetization of  
10 said second magnetic layer.

1                   4. The magnetic recording medium as  
2 claimed in claim 1, wherein said coercivity  $Hc1$  is  
3 smaller than said coercivity  $Hc2$ .

1                   5. The magnetic recording medium as  
2 claimed in claim 1, further comprising:

3                   a coupling intensifying region, provided near a  
4 boundary of said first magnetic layer and said non-  
5 magnetic coupling layer, wherein said coupling  
6 intensifying region intensifies an exchange coupling  
7 strength between said first magnetic layer and said  
8 second magnetic layer.

1                   6. The magnetic recording medium as  
2 claimed in claim 5, wherein said coupling  
3 intensifying region is made of a material selected  
4 from a group consisting of Fe, Co, Ni and alloys  
5 thereof.

1                   7. The magnetic recording medium as  
2 claimed in claim 1, further comprising:

3                   a coupling intensifying region, provided near a  
4 boundary of said second magnetic layer and said non-  
5 magnetic coupling layer, wherein said coupling  
6 intensifying region intensifies an exchange coupling  
7 strength between said first magnetic layer and said  
8 second magnetic layer.

1                   8. The magnetic recording medium as  
2 claimed in claim 7, wherein said coupling  
3 intensifying region is made of a material selected  
4 from a group consisting of Fe, Co, Ni and alloys  
5 thereof.

1                   9. The magnetic recording medium as  
2 claimed in claim 1, further comprising:

3                   a first coupling intensifying region, provided  
4 near a boundary of said first magnetic layer and  
5 said non-magnetic coupling layer, wherein said first  
6 coupling intensifying region intensifies an exchange  
7 coupling strength between said first magnetic layer  
8 and said second magnetic layer; and

9                   a second coupling intensifying region, provided  
10 near a boundary of said second magnetic layer and  
11 said non-magnetic coupling layer, wherein said  
12 second coupling intensifying region intensifies the  
13 exchange coupling strength between said first  
14 magnetic layer and said second magnetic layer.

1                   10. The magnetic recording medium as  
2 claimed in claim 9, wherein at least one of said  
3 first coupling intensifying region and said second  
4 coupling intensifying region is made of a material  
5 selected from a group consisting of Fe, Co, Ni and  
6 alloys thereof.

1                   11. The magnetic recording medium as  
2 claimed in claim 1, which is formed as a patterned  
3 medium, and wherein said first magnetic layer, said  
4 non-magnetic coupling layer and said second magnetic  
5 layer are stacked within each of a plurality of unit  
6 recording portions of the patterned medium.

1                   12. A patterned medium comprising:  
2                   a recording surface; and  
3                   a plurality of unit recording portions,  
4 provided on said recording surface, having  
5 boundaries which are separated from adjacent unit  
6 recording portions,  
7                   each of said plurality of unit recording  
8 portions having a stacked structure comprising:

9                   a first magnetic layer having a coercivity  
10                Hc1;

11                   a second magnetic layer having a  
12                coercivity Hc2; and

13                   a non-magnetic coupling layer provided  
14                between said first magnetic layer and said second  
15                magnetic layer so that said first and second  
16                magnetic layers are exchange-coupled and  
17                magnetizations of said first and second magnetic  
18                layers are antiparallel;

19                   said first magnetic layer having an  
20                exchange coupling field Hex1 which is larger than  
21                both said coercivity Hc1 and said coercivity Hc2.

1                   13. The patterned medium as claimed in  
2                claim 12, further comprising:

3                   a coupling intensifying region, provided near a  
4                boundary of said non-magnetic coupling layer and at  
5                least one of said first and second magnetic layers,  
6                wherein said coupling intensifying region  
7                intensifies an exchange coupling strength between  
8                said first magnetic layer and said second magnetic  
9                layer.

1                   14. A magnetic storage apparatus  
2                comprising:

3                   at least one magnetic recording medium; and

4                   at least one head adapted to apply a field to  
5                the magnetic recording medium;

6                   said magnetic recording medium including:

7                   a first magnetic layer having a coercivity  
8                Hc1;

9                   a second magnetic layer having a  
10                coercivity Hc2; and

11                   a non-magnetic coupling layer provided  
12                between said first magnetic layer and said second  
13                magnetic layer so that said first and second  
14                magnetic layers are exchange-coupled and

15       magnetizations of said first and second magnetic  
16       layers are antiparallel,

17                said first magnetic layer having an  
18       exchange coupling field  $H_{ex1}$  which is larger than  
19       both said coercivity  $H_{c1}$  and said coercivity  $H_{c2}$ .

1               15. The magnetic storage apparatus as  
2       claimed in claim 14, wherein the field from said  
3       head is larger than said coercivity  $H_{c2}$  and smaller  
4       than a switching field  $H_{sw^*}$  which switches the  
5       magnetization of said first magnetic layer to become  
6       parallel to the magnetization of said second  
7       magnetic layer.

1               16. The magnetic storage apparatus as  
2       claimed in claim 15, wherein said switching field  
3        $H_{sw^*}$  is set to a sum of the exchange coupling field  
4        $H_{ex1}$  and said coercivity  $H_{c1}$ .

1               17. A magnetic storage apparatus  
2       comprising:

3               at least one magnetic recording medium; and  
4               at least one head adapted to apply a field to  
5       the magnetic recording medium;

6               said magnetic recording medium including:

7               a first magnetic layer;

8               a second magnetic layer; and

9               a non-magnetic coupling layer provided  
10      between said first magnetic layer and said second  
11      magnetic layer so that said first and second  
12      magnetic layers are exchange coupled;

13               wherein, during a recording process, the  
14       magnetic field applied to the recording medium is  
15       limited to a range such that magnetizations of said  
16       first magnetic layer and said second magnetic layer  
17       are maintained in either a first antiparallel state  
18       or a second antiparallel state, without entering  
19       into a parallel state, whereby in said second

20        antiparallel state the magnetizations of said first  
21        magnetic layer and said second magnetic layer are  
22        reversed, but still antiparallel, relative to the  
23        magnetizations in said first antiparallel state.

1                18. The magnetic storage apparatus as  
2        claimed in claim 17 further comprising:

3                a coupling intensifying region, provided near a  
4        boundary of said non-magnetic coupling layer and at  
5        least one of said first and second magnetic layers,  
6        wherein said coupling intensifying region  
7        intensifies an exchange coupling strength between  
8        said first magnetic layer and said second magnetic  
9        layer.

1                19. The magnetic storage apparatus as  
2        claimed in claim 17, further comprising:

3                a first coupling intensifying region, provided  
4        near a boundary of said first magnetic layer and  
5        said non-magnetic coupling layer, wherein said first  
6        coupling intensifying region intensifies an exchange  
7        coupling strength between said first magnetic layer  
8        and said second magnetic layer; and

9                a second coupling intensifying region, provided  
10        near a boundary of said second magnetic layer and  
11        said non-magnetic coupling layer, wherein said  
12        second coupling intensifying region intensifies the  
13        exchange coupling strength between said first  
14        magnetic layer and said second magnetic layer.

1                20. The magnetic storage apparatus as  
2        claimed in claim 18, wherein the coupling  
3        intensifying region includes a material dispersed  
4        within a boundary portion of at least one of said  
5        first and second magnetic layers.

1                   21. The magnetic recording medium as  
2        claimed in claim 5, wherein the coupling  
3        intensifying region includes a material dispersed  
4        within a boundary portion of at least one of said  
5        first and second magnetic layers.